PN-ABA-042
ISN 16598

SO
RB10
J82
82

River Valley Development

Dam and Downstream Facilities

ENGINEERING REVIEW,

SUMMARY of ECONOMIC ASPECTS

and

SOCIOLOGICAL ISSUES

United States Agency for International Development

Mogadishu, Somalia

James E. Stephenson, Engineering Consultant
Tom Zalla, Agricultural Economist
Susan Gunn, Sociologist

October 1982

Juba River Valley Development
Baardheere Dam and Downstream Facilities

ENGINEERING REVIEW

SUMMARY of ECONOMIC ASPECTS
and
SOCIOLOGICAL ISSUES

Table of Contents | Page

PART I: ENGINEERING REVIEW

I. Introduction 1

II. The Juba River 1

III. Present Agriculture of the Juba River Valley 2

IV. Development Scheme for the Juba River Valley 2

V. Baardheere Dam and Reservoir 2
- A. Location 2
- B. Access 3
- C. Topography 3
- D. Hydrology 3
- E. Water Quality 4
- F. Sedimentation 4
- G. Dam Site Geology 4
- H. Reservoir Watertightness and Slope Stability 4
- J. Seismicity 5
- K. Availability of Dam Building Materials 5
- L. Dam Design Features 5
  - 1. The Structure 5
  - 2. The Reservoir 5
  - 3. Flood Control 5
  - 4. Hydroelectric Power 6
  - 5. Irrigation Releases 6

VI. Hydroelectric Power Plant and Transmission 6
- A. Level of Study 6
- B. Objective 6

(continued)

Table of Contents (cont) Page

VI. Hydroelectric Power Plant and Transmission (cont)

C. Facilities 6

D. Power and Energy Capacity 6

E. Market and Energy Demand 7

VII. Irrigation System 7

A. Level of Study 7

B. Location and Area 7

C. Gross Water Requirement 7

D. Irrigation Parameters 8

1. Type of System 8

2. Efficiency 8

3. Water Use by Crops 8

E. Irrigation Works 8

1. Supply Intakes 8

2. Distribution Network 9

3. Drainage Network 9

4. Rural Roads 9

5. Design Layout 9

VIII. Investment Costs 9

A. Dam and Power System 9

B. Irrigation System 10

IX. Status of Engineering 12

A. Dam, Power Plant and Transmission 12

1. Consulting Engineer Selection 12

2. Tests and Investigations Pending 12

3. Tender Documents 13

4. Construction 13

5. Completion of the Works and Testing 13

6. Project Operation 13

B. Irrigation System 13

1. Current Status 13

2. Future Activity 14

3. Timing of Future Work 14

(continued)

Table of Contents (cont) Page

X. Environmental Concerns 14

XI. Observations and Conclusions 15

A. Dam and Power System 15

1. Engineering 15

2. Board of Technical Consultants 16

3. Construction Management and Supervision 16

4. Construction Force 17

5. Investment Cost 17

6. Pre-construction Preparation 17

B. Irrigation System 18

1. Engineering 18

2. Construction 19

3. Timing 19

XII. THE BOTTOM LINE 19

APPENDIXES

A - Persons Contacted 20

B - Reference Documents 21

C - List of Irrigation Districts with Cropping Patterns 22

D - Irrigation Areas by River Sector 23

E - Annual Water Requirements by Irrigation District 24

F - Cost Estimate - Dam 25

G - Cost Estimate - Hydropower Station 100 MW 26

H - Cost Estimate - Power Transmission System 27

(continued - PART II)

Table of Contents (cont) Page

PART II: Juba River Development Project and Related Economic and Policy Issues

I. Agricultural Production Systems in the Juba River Valley 28
- A. Rainfed Farming 28
- B. Flood Recession Cultivation 28
- C. Irrigated Agriculture 29
- D. Conclusions on Agricultural Production Systems 29

II. Trends in the Demands for Agricultural Commodities 29

III. Review of Economic Data in IMPRESIT Study 30
- A. Project Overview 30
- B. Key Design Parameters and Assumptions 31
  - 1. Key Design Parameters 31
    - a. Irrigation System 31
    - b. Production Technology 31
    - c. Organization of Production 32
  - 2. Project Assumptions 32
    - a. Irrigation Efficiency 32
    - b. Cropping Intensity 32
    - c. Efficiency of Agricultural Machinery 33
    - d. Crop Yields and Prices 33
    - e. Fuel and Input Prices 33
    - f. Implementation Rate 33
    - g. Available River Flow 34
- C. Included and Excluded Benefits 34
  - 1. Included Benefits 34
  - 2. Excluded Benefits 34

(continued)

Table of Contents (cont) Page

III. Review of Economic Data in IMPRESIT Study (cont)

D. Included and Excluded Project Costs 35

1. Included Costs 35

2. Excluded Costs 35

a. Loss of River Valley Grazing 35

b. Flood Recession Agriculture 36

c. Future Family Farm Irrigation on the River Banks 36

E. Other Considerations 36

1. Environmental Impact 37

2. Soil Classification 37

3. Supply of Inputs and Supporting Services 37

F. Alternative Approaches to the Baardheere Dam and Development of Agriculture in the Juba River Valley 37

1. The No-New-Irrigation Scheme 37

2. Feasibility of Proposed Gravity and Pump Irrigation Systems 38

3. More Flexible Approach to Developing Irrigation Infrastructure 38

G. Summary and Conclusions on the IMPRESIT Study 39

IV. Conclusions and Recommendations for Further Action 40

(continued - PART III)

Table of Contents (cont)

Page

PART III: JUBA RIVER VALLEY DEVELOPMENT: SOCIAL ISSUES

I. Introduction 42

II. Summary of Issues 42

A. Size of Labor Force 42

B. Background and Work Attitudes of Labor Force 43

C. Heterogeneity of Population 44

D. Fuel Requirements 44

E. Displacement of Refugees and Upper Juba Residents 45

F. Removal of Riverine Grazing 45

G. Removal of Flood Irrigation Agriculture 45

H. Forms of Organization 46

J. Interception of Trade and Cross-river Movement 46

K. Land and Water Rights 46

L. Increased Conflicts 47

M. Increased Urbanization 47

N. Changed Nutritional Levels 47

O. Increase in Disease 48

III. Conclusions 49

Juba River Valley Development

Baardheere Dam and Downstream Facilities

PART I

ENGINEERING REVIEW

James E. Stephenson
Engineering Consultant

I. Introduction

This Review is prepared in response to request of the U.S. Agency for International Development Mission to Somalia (USAID/Mogadishu) to make an appraisal of the completeness of engineering work accomplished to date on the proposed Baardheere Dam and related power, irrigation and flood control facilities, and of plans of the Government of the Somalia Democratic Republic to implement the project.

The basic information on which the Review is based came from published documents 1977-1981 and discussions with various Government of Somalia officials. The list of officials contacted and documents reviewed are detailed in Appendixes A and B respectively.

Included as Parts II and III of the Report are summaries of Economic Aspects and Sociological Issues to be presented in separate Reports by Tom Zalla, Agricultural Economist and Susan Gunn, Sociologist, who concurrently reviewed those aspects of the proposed development under a team concept. A fourth member of the team, Otto Baumer, Soils Scientist, did not arrive in Somalia in time for his work to be completed and included in this Report.

II. The Juba River

The Juba River is formed by the confluence of three rivers -- the Dawa Parma, the Genale Doria, and the Gestro -- which rise in the Ethiopian plateau and come together near the border at Dolo whence it crosses into Somalia and flows southward for some 700 kilometers (km) and discharges to the Indian Ocean just north of Kismayo. The Juba is the only river in Somalia with a perennial flow. The average annual discharge entering Somalia is substantial -- about 6000 million cubic meters (MCM). There are no tributaries of note past the border and there is no appreciable augmentation of the flow from rainfall in Somalia. The flow varies widely; the ratio between maximum and minimum annual flows is 3.2 and between maximum and minimum average monthly flows 12.9. Low flows occur in the January-April period, generally dropping to less than 15 cubic meters per second (m^3/s).

III. Present Agriculture in the Juba River Valley

The bulk of present agriculture is rainfed. Rain is scarce and irregular with annual precipitation of only 400 to 600 millimeters (mm). This together with other climatic factors, i.e. wind and temperature, keep yields very low. In addition, severe droughts occur every ten years or so.

Except for small family farms that grow seasonal crops in small areas near the river, the present irrigated agriculture in the Valley, including projects in implementation, occupies less than 21,000 hectares (ha), i.e. existing banana plantations, the Sugar Project, the Jilib State Farm and the Mogambo Project. The water for irrigation comes from run-of-river supply in the Juba which is insufficient during low-flow months.

Some 20,000 - 30,000 ha are utilized to grow seasonal crops by flooding. The crops are grown by family farms in depressions ("desheks") which fill with flood waters from the Juba or other surface waters; as the waters retreat, the crops continue to tap the residual moisture in the soil.

For a detailed presentation on the subject one may refer to Mr. Zalla's "Report on the Juba River Development Project and Related Economic and Policy Issues", Section I.

IV. Development Scheme for the Juba River Valley

Studies by TECHNITAL (1977) and updated/revised by IMPRESIT (1979) show a gross irrigable area in the Valley of 400,000 ha from which some 200,000 - 250,000 ha were identified for possible irrigation projects. The IMPRESIT Study proposed a full development scheme of 223,500 ha organized into 18 irrigation districts -- nine on the right bank (91,900 ha) and nine on the left (131,600 ha).

Essential to the scheme is construction of the Baardheere Dam on the Juba River some 350 km above its mouth on the Indian Ocean which would assure some 4000 MCM of water annually for irrigation with flood storage capability (1100 MCM) to limit flood flows downstream to 700 m^3/s (the limit for avoiding damage). Under the IMPRESIT scheme, irrigation water supplies would be drawn from the river by gravity for 32% of the area and by pumping for 68% of the area. Power for pumping would be supplied from the hydroelectric plant at Baardheere Dam.

V. Baardheere Dam and Reservoir

The source of the material appearing in this Section V is essentially the TECHNITAL feasibility study of 1977 as updated and revised by the COYNE and BELLIER review of 1980.

A. Location: The site selected for the dam is located some 35 km upriver from the town of Baardheere, somewhat less than half way down the Juba River on its course from the Ethiopian border to the Indian Ocean.

B. Access: There is at present no road between the town and the dam site. Some 35 km of road will have to be built from the town to provide access for the construction works. Required imports of materials and equipment will move from the port of Mogadishu to Baidoa and Audinle by paved road (some 275 km) and thence by 165 km of new graveled road now under construction to Baardheere.

C. Topography: In the dam site area the river valley is cut into the plateau as a notch of virtually uniform width and fairly constant alignment over 50m deep and some 550m across at the top. Two nearly vertical cliffs about 10m high form the highest portion of each bank; from the toe of the cliffs down to the river bed, the bank slope is gentle and uniform. The natural river bed is about 115m wide and lies at El. 97m (above sea level) while the valley walls extend above El. 150m.

D. Hydrology: Fortunately fairly long-term stream-guage records are available to form the basis for hydrological design of the Baardheere Dam and the downstream development. The Ministry of Agriculture has been recording stage levels of the Juba River at Luuq Gannane (about 180 km upstream of the dam site) since 1951. These measurements, in conjunction with stage-discharge rating curves derived by Selchozpromexport (in 1965 and 1973) and Lockwood/FAO (in 1968) from 18 discharge measurements made by Lockwood/FAO at Luuq Gannane in 1963-1964, enabled stage records to be translated into records of monthly river flows.

River flows were first measured at Baardheere in 1963-1964 when 14 discharge measurements were made by Lockwood/FAO. Both Lockwood/FAO and Selchozpromexport used these measurements to derive stage-discharge rating curves and correlate flows between Luuq Gannane and Baardheere (some 180 km downstream).

It is noted that discharge measurements were carried out only for flows upto about 300 m^3/s (about half bank full and about half of average flood flow). The part of the rating curves above that discharge were constructed by extrapolation.

These data form the basis for the many calculations and synthetic sequences run to establish design flood data and perform reservoir operation studies for optimizing power and irrigation releases.

Average annual inflow into the reservoir was determined to be some 6000 MCM and the 100-year return frequency flood was established at 2000 m^3/s.

With respect to future upstream abstractions (in Ethiopia) that would diminish the inflow into the Baardheere Reservoir, the MACDONALD Report (1978) estimated the possible scale of irrigation development upstream of Dolo. The total area of irrigable land identified was 60,000 ha with an annual water requirement of 770 MCM. MACDONALD's "worst case" estimate which included

upstream urban and industrial development, reservoir losses (evaporation) for hydro schemes etc., came to 2000-2250 MCM annually but with emphasis "... that this is based on a generous estimate of upstream consumption most of which is unlikely to materialize for many years". Even at such a level of abstraction, the project would still be essentially operable (3,617 MCM irrigation requirement) with some reduction in level of hydropower generation.

E. Water Quality: The salts of the Juba waters originate mainly from gypsum formations through which the Gestro tributory flows in Ethiopia and the Juba encounters in the Luuq area. TECHNITAL conducted water sampling and quality testing in 1976. It concluded that the likelihood "... of dangerous increase of concentration in the reservoir waters appears very remote".

F. Sedimentation: The Juba waters are reported to carry high sediment loads during flood stage. TECHNITAL initially reserved 500 MCM of the gross storage of Baardheere Reservoir for reservoir sedimentation. MACDONALD (1978) checked the general accuracy of this volume by applying sediment-discharge relationship formulas. MACDONALD concluded that the suspended sediment discharge of the Juba averages about 5 million tonnes a year, which with bed load sedimentation (10 percent of suspended) would occupy a volume of about 250 MCM over 50 years. The dead storage capacity below Reservoir El. 120m is 280 MCM. The theoretical determination of sediment load needs to be checked by a sampling program even though the reservoir as now designed reserves an apparently generous 1100 MCM for sedimentation.

G. Dam Site Geology: The subsurface geology at the dam site has been investigated by nine boreholes (core drillings) down to 40m below river bottom, by geoseismic and geoelectrical profiles (parallel and normal to the river), and by four trenches dug through the talus (fallen rocks and detritus) covering the slopes. There are two principal formations of interest to dam design: limestones which occur in the upper portion of the valley walls, and marls which occur in the lower portion of the valley walls continuing down and forming the basement structure for the dam. The foundation level will probably be about El. 75, some 20m below river bed, where sound grey marl will provide a competent formation from which to raise the dam structure.

H. Reservoir Watertightness and Slope Stability: The grey marls on which the dam will be founded dip gently upstream and underlie the entire reservoir before taking an upturn and daylighting some 150 km upstream. The unweathered grey marls are a watertight formation. Part of the rocks that cover the grey marl and form the reservoir banks are more pervious in nature. The presence of substantial thickness of jointed limestone and localized karstism (solution channels) over significant heights on both banks may result in hidden absorptive capacity. If substantial it could slow down the first filling of the reservoir and later add to its yield. The nature of the rocks forming the reservoir banks is such that no major slope stability problem should arise around the rim of the lake.

J. Seismicity: The limited data on earthquake tremors indicate that the activity around Baardheere is located within the main rift valley system (650 km away) and to a lesser extent in the Eyasi-Manyara region of north central Tanzania (820 km away). The available records indicate that no major seismic events have occurred close to Baardheere. Enquiries made by TECHNITAL among local inhabitants around Baardheere elicited the information that no tremors had been felt within living memory. Nonetheless the design of the dam will include a safety factor making some allowance for seismic effects.

K. Availability of Dam Building Materials: Local building materials available at or near the site are limited to: Low plasticity fines (probably in limited supply) of dubious suitability for core material for an earth of rockfill dam, alluvial sands available in large quantities but requiring dredging of the river bed, and limestone rocks that can be quarried in virtually unlimited quantities between El. 132m and El. 145m on both banks.

L. Dam Design Features:

1. The Structure

The proposed dam will be concrete gravity type rising some 53m above the 115 meter-wide natural stream bed and 75m above lowest foundation level. It will be about 500m long at crest El. 150m. Its construction will require about 700,000 cubic meters of concrete.

Incorporated in the structure will be an ungated overflow spillway (El. 145m), low-level sluices (bottom outlets) for downstream irrigation water releases or flood flows, as required, and penstocks to serve the hydropower plant at the toe of the dam on the right side.

A mid-level intake and outlet to serve a gravity supply canal to irrigation districts in the vicinity of Baardheere may also be provided.

2. The Reservoir

A 4,100 MCM reservoir at operating design level, El. 145m, will extend some 136 km upstream with a surface area of 375 square kilometers (km^2). At maximum flood level El. 148m the reservoir will cover 465 km^2 and extend almost to Luuq Gannane. Thus the reservoir is long and narrow with much of its length entrenched between steep sides which will minimize flooding of inhabited areas. The reservoir is sized to provide 1100 MCM of capacity for sediment deposition, 1900 MCM for regulated flows, and 1100 MCM for flood control (the top three meters of the reservoir, between operating level and spillway crest).

3. Flood Control

The primary design consideration was to limit downstream flow during a 100-year frequency flood (2000 m^3/s) to no more than 700 cubic meters per second which corresponds to within-bank channel capacity. The reservoir and outlet works have such capability. With respect to dam safety against over-topping, the TECHNITAL proposed design would discharge a 1000-year return frequency flood (2560 m^3/s) at the rate of 1290 m^3/s.

4. Hydroelectric Power

Release of water from the reservoir to the 100 megawatt (MW) hydropower station would be made through simple gated intakes in the dam body to four 3.5m-diameter steel penstocks passing through the dam to the power plant at the toe of the dam on the right bank. Power drafts would be correlated with downstream irrigation/minimum flow maintenance requirements.

5. Irrigation Releases

The requirements for irrigation water in excess of that released through the hydropower plant will be discharged to the natural river channel through regulated bottom outlets in the dam. Up to 50 m^3/s may be provided through a mid-level intake and conduit for gravity feed to the Baardheere area.

VI. Hydroelectric Power Plant and Transmission

A. Level of Study

The design of the power plant and related transmission facilities has gone through successive revisions related to the proposed market, the latest by COYNE and BELLIER (1981). It will be fine-tuned with a study included in the scope of work for the consulting firm who will undertake detailed design of the dam and power plant (proposals now being evaluated). [redacted]

B. Objective

[redacted]

C. Facilities

The power facilities will consist of a 4-unit, 100 MW hydropower station at the toe of the dam with the power sent out over a 225 Kilovolt (KV) transmission line to Mogadishu with a 150 KV line supply to the Juba Valley area; a total of about 530 km of 225 KV line and 195 km of 150 KV line with substations at Mogadishu, Dujuma, Baardheere, Sakow, Jilib, Jamama and Kismayo.

D. Power and Energy Capacity

The 100 MW plant would have a firm capacity (related to continuous discharge capability of the reservoir) of 60 MW, firm annual energy production of 270 GWh (million kilowatt hours) with total annual energy ranging from 400 GWh to 460 GWh.

E. Market and Energy Demand

Mogadishu minimum energy demand has been forecast as 194 GWh in 1988 to 586 GWh in 2017 whereas Juba Valley forecast is 99 GWh in 1988 rising to 275 GWh in 2017. [redacted]

VII. Irrigation System

A. Level of Study

It is emphasized that the irrigation schemes herein described, originally proposed by TECHNITAL in 1977 and updated/revised by IMPRESIT in 1979, "... must be considered as no more than indicative. They have been drawn up to provide a logical, possible framework in which to perform the overall feasibility analysis of the dam" (IMPRESIT Volume 1 - October 1979). The data which follows was extracted from the IMPRESIT Report (1979) which is the latest available.

Topographic data was elicited from 1/100,000 scale maps with 10-meter contour intervals.

Substantially, land classification was based on the 1968 FAO Soil Classification platted at 1/60,000 scale showing the boundaries of soil units identified by photo-interpretation. This data was supplemented by material on Sakow district and the Sugar Project. IMPRESIT made a field reconnaisance of the valley in 1978 which included examination of forty soil profiles in areas considered most interesting and representative.

In summary, the irrigation system proposed by IMPRESIT is deemed (by the writer) only "pre-feasibility grade" level; much more work will be required at feasibility and detailed design levels in classifying soils, delineating cropping areas and developing detailed irrigation works to serve them.

B. Location and Area

IMPRESIT proposes 18 irrigation districts at various points along the Juba River (nine on the left bank, nine on the right) between Baardheere and Kismayo. The aggregate irrigated area comes to 223,500 ha gross with individual districts ranging in size from 700 ha to 36,500 ha. See Appendix C hereto for a listing of Irrigation Districts by location, crops, and area; and Appendix D for summary of areas along reaches of the river.

C. Gross Water Requirement

The annual water requirement at full development is estimated at 3,617 MCM with the requirement per District ranging from 9 MCM to 555 MCM. See Appendix E hereto for a listing of water requirements by District.

D. Irrigation Parameters

1. Type of System

In consideration of the alkalinity/salinity of most of the lands on which seasonal crops will be grown (requiring large amounts of water to leach out salts in the root zone) and the energy cost associated with a sprinkler scheme, the design of the system is based on surface irrigation except for the Sugar Project where a sprinkler system is already in operation.

2. Efficiency

A field efficiency of 0.55 is envisaged for all the crops except sugar cane under sprinkler irrigation at 0.70, and rice at 0.50.

The conveyance and distribution loss downstream of river diversion has been put at 25% of field requirements; river bed losses are assumed to be balanced by return irrigation water.

The average net/gross area ratio was evaluated at 0.82.

3. Water Use by Crops

Under the IMPRESIT scheme, the peak unit water requirements at field level, liters per second net irrigable area (l/s x ha) are:

Sugar Cane	1.40 l/s x ha	(22-24 hours)
Perennial Crops	2.77 " "	(12-24 hours)
Seasonal Crops	2.06 " "	(12-24 hours)
Rice	1.35 " "	(24 hours)

The annual volumes at field level required, cubic meters per net irrigable area (m^3/ha) are:

Sugar Cane	21,400 m^3/ha
Perennial Crops	27,350 "
Seasonal Crops	12,750 "
Rice	18,800 "

E. Irrigation Works

1. Supply Intakes

Irrigation water supplies are envisaged to be taken from the river in three different ways:

(a) A gravity supply canal fed from the dam reservoir via an intake at the dam may serve some 36,500 ha in the Baardheere area;

(b) A gravity supply from existing Fanoole Diversion Barrage would serve some 35,900 ha;

(c) The other areas aggregating 151,100 ha (68% of the total area) would receive water supply from pumping stations at river intakes.

2. Distribution Network

The distribution network envisaged is the normal gravity system: Main canal (fed from river pumping station) following the valley alignment with the necessary gradient to command the irrigation district. These mains would feed smaller branch or secondary canals which in turn feed still smaller secondary and tertiary canals. Inlet structures in the tertiaries feed basins in the rice areas, or field ditches in the seasonal or perennial crops. In the current scheme all canals are unlined. The network would of course contain gates, flumes, and checks to measure and control the water.

3. Drainage Network

A drainage network will be built in conjunction with the irrigation network. Main and branch drains will carry external run-off through the irrigation district. Secondary and tertiary drains will pick up rainwaters and return irrigation waters. They help control the water table and are essential for leaching of salts from the root zone of crops.

4. Rural Roads

Rural roads will follow canal alignments.

5. Design Layout

IMPRESIT's design for cost estimating employed basic module irrigation units; for rice a gross area of 30 ha; for seasonal crops 29.5 ha; and for perennial crops 23.7 ha. Distribution and drainage nets were laid out for these modules which formed the basis for costing. The modules utilize spacing of secondary canals and drains at 1000m, 830m and 765m respectively, with tertiary canals and drains spaced 300m - 355m.

Each irrigation district was delineated on 1/100,000 maps and the principal irrigation and drainage works laid out, enabling quantity estimates for costing in conjunction with the module units described above.

VIII. Investment Costs

A. Dam and Power System

The best costs available for the dam were estimated by COYNE and BELLIER in its April 1980 Report "Baardheere Flood Detention Reservoir - Final Report on Review". Its estimate developed quantities for major work items and applied unit prices "... derived by a comprehensive analysis of

the rates for similar types of work carried out on a worldwide basis in recent years but adjusted to take into account particular circumstances relevant to Baardheere Dam". The total estimate for civil works came to So.Sh. 927 million (at 1979 prices) or $146 million (US $1.00 = So.Sh.6.35) See Appendix F for details. Later the cost of the dam access road, power plant civil works, and gate and valve equipment for the dam were added bringing the total cost up to So.Sh. 1170.9 million ($184.4 million). The best cost estimates available for the power station and transmission lines were estimated by COYNE and BELLIER in its January 1981 Report "Review of the Baardheere Reservoir - Preliminary Study for Optimum Unilization of Power Produced by the Juba Valley Project". It included a line item estimate for hydropower station and dam equipment, aggregating So.Sh. 222.9 million ($35.1 million) and a line item estimate for the transmission system aggregating So.Sh. 528.2 million ($83.3 million), all at January 1979 prices. See Appendixes G and H respectively for details.

To recapitulate, and including the building/improving of the highway from Baidoa to Baardheere town:

Project Component	So.Sh. (million)	U.S.$ (million) (Equivalent)
Dam	1170.9	184.4
Power Station	222.9	35.1
Transmission Lines	528.2	83.2
Subtotal:	1922.0	302.7
Highway - Baidoa to Baardheere (Estimated Cost, Government of Somalia)	185.7	29.3
	2107.7*	332.0

*The cost estimate for the project presented in the Ministry of Planning's "Synthesis of the Baardheere Dam Project", December 1980 came to So.Sh. 2089.4 million (without price contingency). This difference of less than 1% from the total in the above table is attributed to slight differences in application of engineering and physical contingency allowances.

In summary, for the dam power plant and transmission lines, excluding the cost of the highway currently under construction, the Government of Somalia is looking at a $300 million project at 1979 prices, the foreign exchange component of which will be 80-90% on the COYNE and BELLIER assumption that half of the labor force will be imported.

B. Irrigation System

The best costs available for the irrigation system were estimated by IMPRESIT in "Updating and Revision of the Juba River Valley Development Plan", 1979, Volume IV, Engineering. The estimate was prepared from layouts of each irrigation district, estimated quantities of major work items -- excavation, concrete, steel, etc. -- and applied unit prices at 1979 levels. A summary of the total project cost (excluding the Sugar Project) for a gross area of 210,000 ha follows:

Item	Cost So.Sh. (Million)	Foreign Exchange (percent)
Intakes & Lifting Stations		
- Civil Works	277.5	71
- Equipment	138.1	83
Main & Branch Canals		
- Civil Works	2,005.1	74
- Equipment	47.1	
Main & Branch Drains		
- Civil Works	835.8	74
Secondary & Tertiary Canals and Drains		
- Civil Works	5,445.0	71
Subtotal:	8,748.6	
Physical Contingencies 10%	874.9	
Engineering 6%	577.4	
Total:	10,200.9	73%
Say	10,200*	

*U.S. $1.00 = So.Sh. 6.35 = $1,606 million (equivalent)

The above total cost equates to a cost per hectare of So.Sh. 48,570 ($7,650). To this must be added on-farm costs of clearing and levelling, field ditches, field drains, etc., estimated by IMPRESIT at So.Sh. 8,320 for a total per hectare development cost of So.Sh. 57,000 ($8,967 say $9,000).

IX. Status of Engineering

A. Dam, Power Plant and Transmission

1. Consulting Engineer Selection

The Government of Somalia has received and virtually completed technical evaluation of proposals to finalize the design of the dam, power plant and transmission lines and to prepare detailed designs and tender documents. It is expected that price evaluation and selection of consulting firm for contract award will be completed by December-January next. The "short-list" of five firms or joint ventures submitting proposals consisted of Consulting Engineers of good international reputation and included: Sir Alexander Gibb and Partners; Electricite de France; Lahmeyer and Sogriah; Electroconsult; and a consortium of Watermeyer, Lotti, Eubank and Weidelplan.

2. Tests and Investigations Pending

Under the Terms of Reference of the proposals mentioned above, certain tests and studies must be carried out to confirm the basis for final design, including:

(a) Further geological testing to establish final criteria for dam structure design;

(b) Hydrogeological investigation and grouting tests to enable design assuring watertightness of the foundation and abutments;

(c) Update hydrology for the dam site and carry out optimization studies for reservoir operation and flood routing, leading to final establishment of operating and crest levels for the dam;

(d) Hydraulic model tests for finalizing the river diversion scheme, flood discharge arrangements and energy dissipation devices;

(e) Alternative designs for solid gravity and buttress-type concrete dams with comparative costs to enable final design for tender documents;

(f) Updated power market study for use in final optimization of power plant equipment and transmission system;

(g) Develop final design for irrigation discharge outlet.

Design memoranda and a comprehensive Design Report will be prepared by the Consulting Engineer to describe and justify all components of the arrangements proposed.

3. Tender Documents

It was asserted that draft tender documents were expected from the Consulting Engineer in 13 months with publication of tender documents within 18 months. This is deemed to be optimistic. Starting from January 1983 it is considered unrealistic to expect better performance than:

- Negotiation of Consultant Contract : 6 months
- Investigations and Design Studies : 6 - 12 months
- Final Design and Preparation of Tender Documents: 12 - 18 months

The above with an elapsed time of 2-3 years carries one to 1985-1986.

4. Construction

Tendering up to award of contract will require 8-12 months. The Consulting Engineer proposals mentioned above will include supervision of construction as Stage II work. Construction itself will require 4-5 years. Thus the overall elapsed time is 5-6 years which carries one to 1990-1992.

5. Completion of the Works and Testing

Fortunately the reservoir will fill to operating level within the first year of closure -- a matter of months if closure is made at the onset of the fall rainy season. One could then expect initial run-in and testing of hydraulic, mechanical and electrical equipment to be completed in 12-18 months after closure: Project in beneficial operation earliest 1991; reasonable latest 1993.

6. Project Operation

Operation of the dam, power station and transmission system will require expatriate assistance for at least two years, likely longer. An operations/maintenance/training contract with an experienced firm is indicated until Somali personnel have sufficient hands-on operation and maintenance skills.

B. Irrigation System

1. Current Status

The latest engineering work on the irrigation portion of the project is represented by the IMPRESIT Report (1979). It served to locate and delineate the areas, develop basic features of the irrigation districts,

and estimate costs from generalized layouts sufficient for input into the study for the overall Juba Valley development plan. It was not taken to great technical detail with respect to specific works to be built in the individual districts.

2. Future Activity

There are no current arrangements for follow-on technical/economic work. The next logical sequence of steps is the preparation of detailed technical and economic feasibility studies -- by districts -- followed by preparation of engineering plans and construction specifications. As one would be dealing with a number of individually contained systems, each with its own supply intake, it would not be necessary to proceed simultaneously with the above for the entire 223,500 ha development. Conversely, given the enormous investment and magnitude of the physical effort involved it would make the greatest sense to proceed in small "bites" -- a district or two, or portion, at the time with selection made according to priorities as determined by the Government of Somalia.

3. Timing of Future Work

With completion of the dam, and hence the irrigation water supply some ten years away, one has the time to develop well-considered development and implementation plans. For example, there is no use in undertaking the construction of physical works until the pre-requisites for productive irrigated farming are assured: manpower, equipment, materials, technical support.

X. Environmental Concerns

None of the studies or reports examined focussed on environmental benefits or problems that might result from building and operating the project. It assuredly will have a significant environmental impact which should be examined in detail as early-on as possible, for example:

Upstream of the Dam

- Flooding of inhabited areas
- Loss of agricultural/range land
- Loss of forested land
- Effect on marine and animal ecology
- Effect on health of people and animals.

Downstream of the Dam

- Effect on river regime with raised minimum-diminished maximum flows
- Minimum flow necessary to maintain needed supply to downriver communities
- Effect on riverine agricultural and grazing lands, including "desneks"
- Effect on marine and animal ecology.

Irrigated Area

- Effect on the land
- Effect on the people
- Effect on wild life
- Effect on range lands/animal husbandry
- Biological and health effects.

The above listing is not conclusive but serves to indicate the magnitude of change that may be brought about by a project such as anticipated on the Juba.

It is noted that a UNEP group visited Somalia earlier this year charged with drawing up terms of reference for an environmental study. Their report has yet to be received by the Government of Somalia -- reportedly due in June.

What is required is a first-class environmental assessment of the project's effects performed by an integrated group of experienced professionals at the earliest possible time.

XI. Observations and Conclusions

A. Dam and power System

1. Engineering

At this juncture the Government of Somalia is proceeding logically in the development of sound design and construction plans. The Scope of Work on which the technical proposals in hand are based is excellent and suited to the purpose. The firms who have submitted proposals are among the leaders in the international engineering community.

The following are identified as items needing attention that should be added to the Consulting Engineer's scope of work:

(a) Establish as early as possible a [redacted] in the Juba River upstream of the dam site as a check on previous theoretical calculations on the rate of sedimentation in the reservoir.

(b) Establish as early as possible a [redacted] in the Juba upstream of the dam site to establish the degree of salinity at various river stages, and the likely effect on reservoir water quality.

(c) Include in reservoir [redacted] and power optimization studies [redacted] 1979) in order to [redacted] for flood recession cultivation.

(d) [redacted]. In addition to the usual parameters, the update should specifically include:

- re-examination of the benefits attributed to flood control (the figure used by COYNE and BELLIER (1981) was almost double that used by IMPRESIT);

- losses/benefits in connection with twice annual flooding of "desheks";

- sensitivity analysis of the effect of upstream abstractions up to the limit of 2,000 MCM annually suggested by MACDONALD (1978).

2. Board of Technical Consultants

It is common practice on most large dam projects for the Owner to have a Board of Technical Consultants to provide an overview of unusual or troublesome site conditions, major design features, and construction methods or problems. Such a Board is appointed by the Owner, meets once or twice a year -- at site or at the Consulting Engineer's offices -- for three or four days to review and approve critical design or construction features and assist with solutions to technical problems. The Board is usually composed of three to five of the most technically competent and experienced individuals that are available in the desired fields -- for example, dam design, engineering geology, hydraulics, hydrology, hydropower.

It is strongly recommended that the Government of Somalia appoint such a Board of Technical Consultants.

3. Construction Management and Supervision

Clearly the construction of Baardheere Dam is an ambitious, indeed a prodigious undertaking for the Government of Somalia. Normally on such a project the Owner has a parallel staff of engineers, inspectors, accountants, etc. working in conjunction with the Consulting Engineer's force. As such technical people are in extremely short supply in Somalia the responsibility for management/supervision/inspection will fall primarily on the Consulting Engineer. Nonetheless it is important that the Government of Somalia field the strongest team possible, in qualification and numbers, for its on-site organization to interact with (and learn from) the Consulting Engineer along clearly drawn lines of authority.

4. Construction Force

The observation by COYNE and BELLIER (1980) that at least half of construction labor will come from outside Somalia has considerable cost implication, both in magnitude and ratio of local to foreign exchange cost. Obviously a great many artisans and skilled workers will of necessity have to come from outside the country. However the Government of Somalia should make every effort to attract labor to the site not only for unskilled work, in the first instance, but also as material for training by the Contractor for skilled or semi-skilled jobs.

5. Investment Cost

Firm figures for dam and power system investment costs will be known only when the Consulting Engineer completes final design, say 1984-1985. Clearly it will be far in excess of (likely more than double) the approximately $300 million estimate mentioned above based on January 1979 prices. This of course adds to the difficulty of organizing consortium financing at this juncture.

6. Pre-Construction Preparation

A number of items need attention by the Government of Somalia to enable the construction contractor to proceed with effective work at the site early-on after signing the contract. These include:

(a) Baidoa-Baardheere Highway

Completion of the 165 km stretch of new road between Audinle and Baardheere that is now under construction. Present plans are that it be surfaced with gravel only. If at all possible the road should be paved before dam construction begins; otherwise, maintenance under construction traffic will be a problem.

(b) Access Road Baardheere Town to Dam Site

If the site access road were built prior to signing of the dam construction contract, it would significantly shorten the construction schedule as the contractor could begin moving-in and commence work at the site without delay.

(c) Worker Housing

The dam contractor will need local labor in considerable numbers from the onset of work at the site. If the Government of Somalia made even a modest start at providing worker housing in the area it would no doubt attract a labor force to work for the contractor.

(d) It has been reported that a feasibility study has been completed for a cement plant at Baardheere, and that financing is being sought for its construction. Such a plant -- about 3½ years estimated for construction -- would have a significant impact on dam construction costs. It would obviate the importation of cement for the dam and powerhouse, thereby saving foreign exchange, and eliminate port handling and trucking of cement some 450 km from the port of Mogadishu at the rate of about 5,000 tons a month for nearly three years.

B. Irrigation System

1. Engineering

(a) Mapping

To proceed with detailed feasibility studies and design of individual areas one needs larger scale topographic and land classification maps than the present 1:100,000 (10m contour interval) and 1:60,000 scale maps respectively. This indicates aerial photography and photogrammetric interpretation to produce the maps for individual irrigation districts.

(b) Topographic and Land Classification Surveys

Supplementing the new larger scale base maps at say 1:24,000 or 1:15,600, ground control would need to be established to be followed up in the detailed design stages with necessary on-the-ground surveys.

(c) Detailed Feasibility Study and Final Design

At such time as the Government of Somalia decides to proceed with serious development of the proposed irrigation districts, the following scenario is suggested. Under a staged contract with a competent engineering firm:

(i) Secure aerial photography and development of base topographic and land classification maps described above.

(ii) Select one or perhaps two irrigation districts and proceed with detailed technical and economic feasibility studies. Note: Field efficiency in water use envisaged by IMPRESIT(55% generally) is not believed to be realistically attainable.

(iii) On the basis of feasibility study results, proceed with detailed design of the works and preparation of tender documents for the selected area.

2. Construction

Competitive tenders would be issued for construction of the works: supply intakes, irrigation distribution and drainage networks, and associated roads.

The area(s) taken up for construction should proceed at a pace no faster than on-farm development and effective farm operations can be taken up.

3. Timing

[redacted]. That is dictated by investment costs, organization and management capability, and manpower constraints both at the management and farm level.

[redacted]. Currently only a fraction of that is deemed attainable in terms of beneficial operation -- which is the name of the game! [redacted]

XII. THE BOTTOM LINE

[redacted]

Part I
APPENDIX A

Baardheere Dam and Downstream Facilities
ENGINEERING REVIEW

Persons Contacted - September 30 - October 24, 1982

1. Government of Somalia - Juba Valley Development Ministry

Minister Ahmed Habib Ahmed
Vice-Minister Omar Handulle
Mr. Aweys H. Yusuf, Director of Planning
Mr. Mohamed Hassan Aden, Director of Veterinary Department
Mr. Abdullahi Issa God, Director of Environmental Department
Dr. Heiko Brunken, Economist

Baardheere Dam Project

Mr. Ahmed Qassim, Technical Director
Mr. Mohamed Abshir, Civil Engineer, (Ministry of Planning)

2. ODA Land Resources Development Center (UK)

Land Use Survey Team (Part of Tsetse Fly Control Program)
John Makin, Soils Specialist (Team Leader)
Ray Rose Innes, Range Ecologist
Cary Hendy, Livestock Production Specialist
Mel Errington, Agricultural Economist

3. European Economic Community (EEC), Mogadishu

Mr. P. Badoglio, Civil Engineer

4. USAID/Mogadishu

Mr. James Kelly, Director
Mr. Roger Carlson, Assistant Director
Mr. Jerry Neptune, Agricultural Officer
Mr. James Shea, Projects Officer
Mr. Charles Brooks, Controller

5. U.S. Embassy, Mogadishu

Ambassador Petterson
Deputy Chief of Mission Joseph McLaughlin

Part I

APPENDIX B

Baardheere Dam and Downstream Facilities
ENGINEERING REVIEW

Reference Documents

1. Baardheere Flood Detention Reservoir Feasibility Study (December 1977), TECHNITAL SpA, Rome

2. Baardheere Flood Detention Reservoir Final Design - General Note, List of Documents and List of Drawings (February 1979), TECHNITAL SpA, Rome

3. Updating and Revision of the Juba River Valley Development Plan (October 1979) IMPRESIT SpA, Milan

4. Baardheere Reservoir Review (December 1978), Sir M. MACDONALD & PARTNERS LIMITED, Cambridge

5. Baardheere Flood Detention Reservoir, Final Report on Review (April 1980), COYNE ET BELLIER, Paris

6. Synthesis of the Baardheere Dam Project (December 1980), Ministry of National Planning, Mogadishu

7. Preliminary Study for Optimum Utilization of Power Produced by the Juba Valley Project - Final Report (January 1981), COYNE ET BELLIER, Paris

8. Scope of Consulting Engineering Services, Baardheere Flood Detention Reservoir, Tender Dossier, (November 1981), Baardheere Dam Authority, Ministry of Planning.

PART I

APPENDIX C

IRRIGATION DISTRICTS

IRRIGATION DISTRICTS	GROSS AREA (ha)				
	Sugar Cane	Perennial Crops (1)	Seasonal Crops (2)	Rice	Total
1R BAARDHEERE	- (-)	- (-)	2,400 (100%)	- (-)	2,400
1L BAARDHEERE	- (-)	- (-)	10,000 (100%)	- (-)	10,000
2R BAARDHEERE	- (-)	- (-)	700 (100%)	- (-)	700
2L BAARDHEERE	- (-)	- (-)	36,500 (100%)	- (-)	36,500
3R ARUSURRE	- (-)	- (-)	7,700 (100%)	- (-)	7,700
3L SAKOW	- (-)	- (-)	2,000 (32.79%)	4,100 (67.21%)	6,100
4R SAKOW	- (-)	- (-)	8,000 (33.20%)	16,100 (66.80%)	24,100
4L SUD-SAKOW	- (-)	- (-)	1,200 (8.16%)	13,500 (91.84%)	14,700
5R SUD-SAKOW	- (-)	- (-)	1,300 (15.30%)	7,200 (84.70%)	8,500
5L FANOOLE	- (-)	1,700 (5.48%)	9,200 (29.68%)	20,100(64.84%)	31,000
6R KAITOY	- (-)	1,000(100%)	- (-)	- (-)	1,000
6L HOMBOY	- (-)	- (-)	4,900 (100%)	- (-)	4,900
7R SUGAR PROJECT	13,500 (100%)	- (-)	- (-)	- (-)	13,500
7L KAMSUMA	- (-)	2,600 (100%)	- (-)	- (-)	2,600
8R QUALANYA	- (-)	3,500 (11.33%)	27,400 (88.67%)	- (-)	30,900
8L JAMAAME	- (-)	2,500 (14.97%)	14,200 (85.03%)	- (-)	16,700
9R YOONTOY	- (-)	1,000 (32.26%)	2,100 (67.74%)	- (-)	3,100
9L BAGDOAD	- (-)	1,100 (12.09%)	8,000(87.91%)	- (-)	9,100
T O T A L	13,500 (6.04%)	13,400 (6.00%)	135,600 (60.67%)	61,000 (27.29%)	223,500 (100.00%)

(1) Grapefruit + Banana

(2) Cotton + Groundnuts + Maize + Family farm crops

(Source: INRESIT 1979)

Part I - APPENDIX D

Irrigation District	Technital Plan (ha)	Impresit Revision (ha)
Upstream of Baardheere	19,250	-
Between Baardheere and Sakow	57,000	57,300
Between Sakow and Boale	32,900	53,400
Between Boale and Fanoole	13,070	-
Between Fanoole and Joontoy	121,410	112,800
Dufalak - Deshek Wamo	20,965	-
TOTAL GROSS AREA	264,595	223,500

(Source: IMPRESIT 1979)

ANNUAL WATER REQUIREMENTS AT RESERVOIR LEVEL (Mm^3)

IRRIGATION DISTRICTS	Gross Area (ha)	Water Requirement (Mm^3/year)
1R BAARDHEERE	2,400	31
1L BAARDHEERE	10,000	130
2R BAARDHEERE	700	9
2L BAARDHEERE	36,500	476
3R AROSURRE	7,700	104
3L SAKOW	6,100	105
4R SAKOW	24,100	414
4L SUD-SAKOW	14,700	276
5R SUD-SAKOW	8,500	156
5L FANOOLE	31,000	555
6R KAITOY	1,000	28
6L HOMBOY	4,900	64
7R SUGAR PROJECT	13,500	296
7L KAMSUUMA	2,600	73
8R QALANJA	30,900	455
8L JAMAAME	16,700	255
9R JOONTOY	3,100	55
9L BAODOAD	9,100	135
TOTAL	223,500	3,617

(Source: IMRESIT 1979)

Gravity/buttress concrete dam

Item	Unit	Quantity	Rate (So.Sh.)	Amount
Excavation for dam foundations :				
Soft	m3	345,000	25	8,625,000
Rock	m3	430,000	65	27,950,000
Pre-splitting	m2	4,500	60	270,000
Shuttering :				
Exposed Surfaces	m2	117,000	220	25,740,000
Joints	m2	29,000	220	6,380,000
Other	m2			
Reinforcement :	t	2,100	7700	16,170,000
Concrete (excluding cement) :				
Dam	m3	615,000	355	218,325,000
Stilling Basin	m3			
Cement :	t	151,000	900	135,900,000
Grouting :				
Drilling	m	8,000	635	5,080,000
Cement	t	1,700	6350	10,795,000
Drainage Drilling :	m	2,300	635	1,461,000
River Diversion :				
Soft Excavation	m3	600,000	25	15,000,000
Fill (cofferdam)	m3	360,000	30	10,800,000
Diaphragm wall (concrete)	m2	30,000	2570	77,100,000
Penstock steel linings	SUM			4,890,000
Total of Measured Items				554,986,000
Unmeasured Items (10 %)				55,398,600
Sub Total				610,384,600
Contingencies (15 %)				93,057,690
Sub Total				703,442,290
General items (30 %)				214,032,687
Estimated Total				927,474,977
SAY				927,000,000

(Source: COYNE et BELLIER 1980)

COST ESTIMATES - HYDRO-POWER STATION 100 MW -
(including dam equipment)

10^6 So Sh

DESIGNATION	YEAR 1	YEAR 2	YEAR 3	TOTAL
1) First stage				
Gates and valves	-	4,50	4,58	
Intake equipment	0,45	0,75	0,45	
Turbines, governors	6,75	27,00	9,45	
Butterfly valves	-	3,60	3,68	
Generators	9,00	31,50	11,34	
Transformers	-	0,90	6,75	
225 kV switch yard	-	3,00	10,88	
Auxiliary equipment	-	-	18,03	
Engineering	-	3,13	4,50	
Physical contingencies	-	6,24	9,00	
Total	16,2	80,6	78,7	175,5
2) Second stage	5,3	22,7	19,4	47,4
TOTAL				222,9

(Source: COYNE et BELLIER 1981)

5.3. Cost estimate

Costs are expressed in million So.Sh (1979 value) and include for engineering plus 10% contingency.

Switchyard included in powerstation cost

225 kV line : Powerstation to Dujuma 150 km x 0.680	102.00		
Dujuma to Mogadisnu 380 km x 0.680	258.40		
Sub-total (a)		360.4	
Dujuma substation : 2 transformer bays	5.55		
2 outgoing feeder bays	6.13		
1 potential transformer bay	1.20		
1 no. 50 MVA 225/150 kV transformer	3.08		
1 no. 30 MVA transformer	2.55		
1 reactive power compensator (static)	9.00		
Sub-total (b)		27.5	
150 kV line : Dujuma to Kisimayo 195 km x 0.48	93.60		
Sub-total (c)		93.6	
Mogadisnu substation : 1 incoming line bay	3.08		
2 transformer bays	5.55		
1 no 30 MVA transformer	2.55		
1 no 70 MVA transformer	4.43		
1 reactive power compensator (static)	9.00		
Sub-total (d)		24.6	
150 kV substation (5 no. 225 kV/MV substation)	22.1		
Sub-total (e)		22.1	
GRAND TOTAL		528.2	

(Source: COYNE et BELLIER 1981)

PART II

The JUBA RIVER DEVELOPMENT PROJECT and RELATED ECONOMIC and POLICY ISSUES[1/]

I. Agricultural Production Systems in the Juba River Valley

In broad terms, rainfed farming appears to dominate in the upper Juba River Valley and in the middle Valley farther down the river. Flood recession agriculture is most important from Sakow downstream, and irrigated farming along the lower reaches of the river. According to an FAO study some 70,000 hectares (ha) were cultivated along the river in 1963-1964, of which about 28,000 ha were rainfed, 40,000 ha were flooded and, 2100 ha were under controlled irrigation. Current cultivated area may be considerably higher as estimates of crops destroyed by the 1981 flood of the Juba River range between 54,000 ha and 67,000 ha. Apparently fairly large cultivated areas were untouched by the flood.

A. Rainfed Farming

Rainfed farming concentrates on sorghum, sesame and groundnuts with some maize in depressions and scattered plots. Yields are low for all rainfed crops in the valley; partly because of relatively sparse and irregular rainfall, but also because of defensive cultural practices: hedging against failure of seed to germinate and conservation of moisture.

Rainfed farms appear to seldom exceed four hectares except in the upper Juba Valley where they may go up to eight hectares. Production technology on rainfed farms in general is quite rudimentary involving few inputs other than seed, labor and handtools.

B. Flood Recession Cultivation

Traditionally the agricultural peoples of the Juba River Valley rely heavily on flood recession cultivation of areas along the river and around natural depressions or catchments called "desheks". These catchments gather both excess rainfall and floodwaters from the river. Often the land receives either too much or too little water with the result that yields are said to be not much better than adjacent rainfed areas in years of normal rainfall.

It appears that maize is the principal crop in the "desheks" and along the river in much the same way as sorghum is in the rainfed areas. Cotton is also important during the GU (spring) rains as are sesame, beans and a few interplanted vegetables. Some flood recession land is plowed with a tractor, but apart from the generally greater availability of water, other cultural techniques do not seem to differ substantially from rainfed techniques.

1/ A condensation by James Stephenson of a full Draft Report completed by Tom Zalla, Agricultural Economist, in Mogadishu, October 17, 1982.

C. Irrigated Agriculture

Irrigated agriculture in the Juba River Valley concentrates more on cash crops such as bananas, sugar cane, citrus, rice and cotton than do the other types of agriculture. According to TECHNITAL (1979) about 9,500 ha of land are cultivated under controlled irrigation, apparently excluding the state projects. About one quarter of the area is planted to either maize or sorghum, mostly the former. At the present time about 5,000 ha are planted in bananas, 4,000 of which are under the new banana project.

Production technology on the larger irrigated farms is more sophisticated and yields are generally higher. However, a large proportion of area under both large and small scale irrigation seems to be in systems that do not have sufficient water to permit them to operate independently of available rainfall. Drainage is often poor or non-existent and irrigation efficiency is low. Salts are accumulating in many irrigated soils, depressing yields as a result. In general, productivity of irrigated farms is low under all forms of land tenure.

The IBRD in its Somalia Agricultural Sector Review (1981) has observed that the small irrigated farms appear better able to generate employment and produce foodstuffs at a relatively lower cost than state farms. About the most that can be said is that a thorough study of the irrigated farm sector is needed as a prelude to launching major new initiatives in the Juba River Valley.

D. Conclusions on Agricultural Production Systems

Even with the higher level of inputs, large irrigated farms in Somalia do not appear to be much more efficient from the point of view of cost of production than the better half of those farmers relying on receding flood waters to produce maize. One can only speculate on how the costs of production of small farmers would decline if they had access to similar improved production packages, but it seems likely that the decline would be significant.

One has to be careful in drawing conclusions from data as weak as that presented and analyzed in this section of the report. In actual fact, no serious farm management analysis appears to have been done in Somalia. Guesses are formulated, juggled, interpreted, reported and, finally, quoted; by which time, the danger becomes that they might be accepted as fact. SERIOUS STUDY OF ALL FARMING SYSTEMS IN SOMALIA IS NEEDED TO ADDRESS THIS PROBLEM.

II. Trends in the Demands for Agricultural Commodities

The 1980 population of Somalia is estimated to have been around five million nationals with another 600,000 to 1,000,000 refugees in camps or otherwise dispersed throughout the country. Given worldwide experience with refugees, it is estimated that around 15% will remain in Somalia after repatriation of the refugee population. Thus 1980 base population can be taken as 5.1 million people divided between urban, rural settled and nomadic segments.

A rapid growth in urbanization is taking place on top of rapid population growth overall. This is no doubt related to the cumulative effect of several years neglect of the agricultural sector. Real prices for most agricultural commodities have been declining for several years and continue to do so. At the same time the rapid increase in enrollment in schools and the on-going policy of guaranteeing employment to all secondary school graduates is inducing a whole generation of youth to turn away from agricultural pursuits toward "catch-as-catch-can" in the towns. The rapid urbanization which results has a double impact on food deficits: As one mouth is added in the towns, one more pair of hands is lost to the food producing sector.

Overall, Somalia's population is expected to grow at 2.9% per year between 1980 and 2000. At that time the country will have 9 million inhabitants and Mogadishu will be a city of 2 million people. These projections represent nothing more than the impact of current policies if left unchanged.

Considering that actual production will have to be about 15% higher than projected consumption in order to offset processing and distribution losses, the required increase in annual cereals production is estimated at 850,000 tons over and above the 1978-1982 average production of 330,000 tons in order to attain self sufficiency in the year 2000. This would require an annual growth rate in cereals production of 4.8% over the same period -- clearly unattainable under present policies.

III. Review of Economic Data in IMPRESIT Study

A. Project Overview

The Juba River Valley Development Plan as prepared and analyzed by IMPRESIT envisions construction of a 55-meter high concrete dam and 75-90 megawatt (MW) hydroelectric power plant (raised to 100 MW in subsequent study by COYNE and BELLIER) on the Juba River near Baardheere to control flooding and regulate river flow downstream. The dam will create a reservoir 136 kilometers (km) long and will supply electricity to irrigation schemes and civil and industrial users in the Juba River Valley. At full implementation the dam would supply enough electricity and water to irrigate up to 223,500 hectares (ha) of land along the Juba River. The study also evaluates a more modest partial development scheme covering 122,100 ha.

Development of the Juba River Valley along the lines proposed by IMPRESIT would require a total financial investment at 1978 prices of $1.2 billion over a period of 35 years for the more realistic partial development alternative. Of this, approximately $180 million would go to construction of the dam, power plant, transmission lines and related road construction (this compares to $330 million for those same items in 1979 prices according to the COYNE and BELLIER study, which includes an additional 380 km of transmission line from Dujuma to Mogadishu costing $64 million). Dam construction, power production and transmission and related costs, therefore, represent 14.6% of total project costs. As a result, the overall rate of return of the project as proposed by IMPRESIT is not very sensitive to the cost of the dam.

Using the investment and operating cost assumptions of the IMPRESIT study, the overall economic internal rate of return of the Project would be 5.3% for the partial development scheme assuming construction by international general contractors, and an annual cropping intensity of 1.5. This rate of return would decline to 5.1% for the full implementation program, reflecting the greater value to the economy of electricity for civil and industrial use than for agricultural use under proposed design of the agricultural production component.

In a separate study, updating IMPRESIT cost data but adjusting for physical and engineering contingencies and excluding the development of any new irrigated agriculture, COYNE and BELLIER in 1981 obtained an economic internal rate of return of 10.1 - 10.6% depending on the electric energy demand in Mogadishu. This implies that if the electricity supplying the irrigation schemes in the Juba River Valley were valued at its opportunity cost to the economy rather than at the cost of producing hydroelectric power, the rate of return to the IMPRESIT proposal would decline considerably, and very likely would approach zero.

B. Key Design Parameters and Assumptions

1. Key Design Parameters

a. Irrigation System. Under the IMPRESIT proposal 32% of the new area irrigated by the project would be entirely gravity fed from the Baardheere Reservoir and the Fanoole Diversion Barrage. The remainder would be supplied by pumping stations on the river in order to raise water to a main supply canal serving a particular area. Both systems would employ unlined earth canals and concrete structures designed for shift distribution of water with manual regulation of levels and discharges. For more detailed description of the IMPRESIT proposed system see SECTION VII heretofore in Part I, Engineering Review.

b. Production Technology. IMPRESIT envisions a highly capital intensive, highly mechanized, high input technology for increasing agricultural production in the Juba River Valley. The very high cost of establishing one hectare of a large irrigation scheme ($9,000/ha for the irrigation infrastructure alone) requires relatively efficient high-input technology in order to generate the kind of production necessary to make the development of such systems economic. At the same time, a high degree of mechanization was envisioned to enable the project to cope with any labor shortages that might arise as the area under cultivation increases.

This line of argument has several weaknesses. While the need for high-output, efficient production in order to make such a large investment pay off is indisputable, such efficiency will not come from assumption alone. Experience on other large scale irrigation projects in Somalia suggests that the operating efficiency and yields assumed by IMPRESIT are well above those that can be reasonably expected in the absence of major institutional development and policy reform. The IMPRESIT study makes no mention of these and includes none of the costs associated with the strengthening of agricultural support institutions in its calculations. It is not appropriate, therefore, to attribute the benefits of such investments to this particular project in the form of higher operating efficiency and yields.

Though it may be true that existing agriculture projects face labor shortages, it would seem wise in light of current unemployment in Somalia' modern sector to look for other than a highly mechanized solution, beginning with a better understanding of the reasons for these problems. By IMPRESIT's own population projections, labor availability in the valley should not be a problem until 45,000 ha of new land are under cultivation using the much more labor intensive approach suggested by an earlier TECHNITAL study. In addition, the large supply of refugees constitutes a ready supply of labor whenever government policy favors their integration into the national economy. Clearly something more than a mere shortage of numbers is behind current labor problems.

Finally, mechanized agriculture is highly dependent on two items in chronic short-supply in Somalia -- spare parts and skilled labor. Without specific policies and programs to deal with those two problems it would seem most unwise to embark on a major expansion of highly mechanized agricultural production in Somalia. The nature of labor problems in Somalia agriculture needs to be better understood.

c. Organization of Production. In conformity with government policy at the time of the study, IMPRESIT envisions organizing state and cooperative farms to cultivate the newly developed areas. Less than 14% of the irrigated land is allocated to individual family farms. The limited quantitative data that are available suggest that state farms can be more productive than large and small private farmers in producing maize, sorghum and rice under irrigated conditions, but they appear to have higher production costs. These data, however, are very weak and contradict the observations of a recent IBRD report based on a fairly extensive examination of agricultural production in Somalia. However, Somalia has very little experience with government organized small holder settlement schemes under irrigation. Thus a serious study of yields and production costs on different kinds of irrigated farms in Somalia would provide useful information for identifying efficient systems for exploiting irrigated agriculture in the country.

2. Project Assumptions

a. Irrigation Efficiency. The higher the level of irrigation efficiency the lower the cost of supplying water for irrigation. Thus substantial changes in irrigation efficiency can have a major impact on production costs and the economic viability of pump irrigation schemes.

The IMPRESIT proposal assumes irrigation field efficiency of 50% for rice and 55% for all other gravity-fed crops. According to the recent IBRD study, the norm on Somali farms, public and private, is closer to 20%; 45% would represent a good level of efficiency. Thus the IMPRESIT assumption seems overly optimistic and, as a result, probably greatly underestimates water pumping costs.

b. Cropping Intensity. Cropping intensity refers to the number of crops per year which are obtained from a given surface of land. To the extent that land is left fallow or otherwise not planted, cropping intensity will fall

below its theoretical maximum of the number of plantings per year. IMPRESIT considers two levels of cropping intensity in its analysis, 1.5 and 1.65. The former represents a good target under African conditons. Current performance is no where near this in Somalia because of limited supplies of water during periods of low river flow. The generally poor performance of irrigated agriculture in Somalia with respect to other performance measures suggests caution against making an overly optimistic assumption concerning cropping intensity.

c. Efficiency of Agricultural Machinery. The one area where a large body of experience has been accumulated is in the area of agricultural mechanization in Africa. For state farms the record is not very good. Somalia is no exception. Yet the IMPRESIT analysis uses operating efficiency assumptions that would look good on an Iowa grain farm. This has the effect of greatly understating the amount of investment in tractors and other machinery required to cultivate a given area.

The IMPRESIT study does not conceal the high degree of efficiency of use of agricultural machinery that it is assuming. It admits that the "extremely rational use of machinery" is necessary if the highly mechanized approach is to have the benefits envisioned. However, efficiency is a lot easier to obtain by assumption than by effective operation and management control during project implementation. More realistic assumptions would probably increase mechanization costs by 50-100% over those used in the IMPRESIT cost calculations, excluding the influence of increases in the unit cost of fuel.

d. Crop Yields and Prices. The prices and yields used by IMPRESIT in calculating the value of incremental production arising from the new irrigated agriculture were compared with similar data in the 1981 IBRD report. Although there were variances with respect to individual crops, overall the two sets of data yield essentially the same results.

Two points need to be emphasized here. The IBRD assumes substantial improvement in the supply of inputs and government services to the agricultural sector while IMPRESIT makes no mention of this. In effect, part of the benefits attributed to the irrigation projects should be attributed instead to investments required to provide the improved infrastructure, research and other services necessary to realize the higher yields. On the other hand, the allocation of area to crops by IMPRESIT was done with an eye toward food self-sufficiency. Less emphasis on food self-sufficiency and more on producing crops which have a higher economic value, such as cotton, sesame, rice and bananas, would substantially improve the benefits of the new irrigated agriculture.

e. Fuel and Input Prices. When IMPRESIT did its study, world oil prices were less than one-half their current level. Thus the real cost of fuel has essentially doubled already instead of by 1995 as originally anticipated. This will have a substantial impact on estimated benefits and costs attributed to the project.

f. Implementation Rate. IMPRESIT considers both a full implementation program involving 203,000 hectares of new irrigated land and a partial implementation scheme of half that amount. The former requires development of new irrigation at an annual rate of 6600 hectares per year and the latter at 3300. Even the smaller figure is well above what has been occurring in Somalia in recent years.

Because of the small proportion of total costs represented by the dam and the modular way in which costs for the irrigation schemes are constructed, the internal economic rate of return is not very sensitive to the lower implementation rate. It does, nonetheless, increase with the lower rate, indicating that the country has much to gain and little to lose by proceeding judiciously with new irrigated development in the Valley.

g. Available River Flow. The Juba River rises in Ethiopia where virtually the entire flow is generated. What Ethiopia decides to do with that water on its side of the border will have a major impact on the feasibility of the proposed dam for any use. As currently designed, the hydropower plant would utilize virtually all the water now coming down the river. Lower rates of flow would have an almost proportional impact on the benefit stream from hydroelectric sales. Depending when or if this occurs, it could have a substantial negative impact on the projected rate of return. For the agricultural program envisioned by IMPRESIT the effect on the rate of return would be less since the dam is a small proportion of total costs and electricity sales a smaller proportion of total benefits. The absolute losses would be greater, however, because of the higher investments envisaged.

A 1978 report by MACDONALD indicated that upstream abstractions could reach as high as one-third of the average annual river flow. Though the study points out that such a level of abstraction is unlikely, it would be wise to simulate the power supply available from the dam assuming more likely lower rates of abstraction in order to determine their impact on the economic benefits of the dam for the "no-new-irrigation" alternative.

C. Included and Excluded Benefits

1. Included Benefits

Agricultural benefits arising from new irrigation on large schemes and electric power have been included, though as indicated earlier, there is room for debate over the amount and relative priority given to each.

The IMPRESIT study includes benefits of flood regulation and control of river flow which are quite reasonable based on actual damage caused by the 1981 flood (MACDONALD Survey, 1981). The calculated benefits appear sufficient to cover damage to small family-operated irrigation pumps and public works though IMPRESIT has not specifically allowed for these in definition of project benefits.

2. Excluded Benefits

According to IMPRESIT, the current area in irrigated cropping by small family farms on the Juba River is not substantial enough to consider in the evaluation of the overall scheme. Other references suggest it could amount to 2000 hectares. In any event, improved flow regulation could provide quite a stimulus to spontaneous expansion of this kind of activity in the future. More needs to be known about the volume and composition of current family farming of this kind before it will be possible to estimate the potential magnitude of such spontaneous development.

Only the MACDONALD (1978) study mentions local river transport as a potential benefit. Given the sparse population in most of the area above the dam, the only important benefits would be on the river below the dam. The existence of the diversion at Fanoole would impede the kind of straight shot from Kismayo that might make river transport of freight an attractive possibility. This excluded benefit does not appear to be worth considering further.

D. Included and Excluded Project Costs

1. Included Costs

In the brief period of time available, it has not been possible to really scrutinize the level of costs assumed for the Baardheere Dam Project as analyzed by IMPRESIT. However, with respect to completeness, most obvious costs are included: roads to the dam site, dam construction, the power station and transmission line, modifications to the irrigation system below the Fanoole diversion, the irrigation distribution network, investment and operating costs for the model farms and costs for supporting a central authority to coordinate development in the Valley. Most of these costs appear to be dealt with in a very professional way.

2. Excluded Costs

A few potentially important costs have been overlooked or brushed aside by IMPRESIT. One of the less costly ones in monetary terms is relocation of the population, including at least two refugee camps now located in what will become the reservoir. Others related to land use may be more substantial. According to a recent FAO report (1981) little is known about the people who now utilize the tsetse infested river valley -- whether on a temporary or permanent basis. It should not be assumed, therefore, that the resources of the valley as currently utilized are economically insignificant. Three areas deserve more attention.

a. Loss of River Valley Grazing. The Juba River Valley serves as a dry season grazing reserve for livestock in the southern third of the country. Its importance appears to be proportional to the severity of the drought. In really bad years, herders risk substantial losses due to trypanosomiasis in order to provide grazing for their livestock in the valley. Informed sources estimate that the grasses of the valley are important to the survival of the livestock in one year out of three and absolutely critical one year out of five.

The value to Somalia of the riverine grazing areas greatly exceeds the value of the digestable nutrients livestock get when feeding there. The existence of this grazing reserve permits a larger number of animals to survive and, as a consequence, to utilize grasses in the dryer, rainfed areas during the rest of the year. In effect, then, the value of this grazing land is a function of the number of deaths avoided, plus the discounted flow of future benefits arising from the offspring, approaching zero as the range is once again fully stocked.

There appear to be important dry season grazing areas in the reservoir area south of Luuq, and all along the river below the dam site. The upper area will be eliminated by the reservoir. The lower area will be greatly reduced by the much lower flood levels and the large expanses of land to be devoted to irrigated agriculture. Reduced flood levels will probably have the greatest effect on grazing lands. This whole question needs further study before the impact of the project on livestock production in Somalia can be accurately assessed.

b. Flood Recession Agriculture. The IMPRESIT study acknowledges that controlling the flow of the Juba River may have a deleterious effect on about 6,000 of the estimated 20,000 - 30,000 hectares of flood recession agriculture. Some of this loss can be avoided by digging canals from the "desheks" to the river to allow inundation with lower levels of flooding. How long such canals would need to be is not mentioned and the cost of digging them is not included.

The negative effects of greater flood control on the "desheks" can largely be offset by creating artificial floods. During the first 15 years of the project, under the full implementation plan developed by IMPRESIT, there would be sufficient water not needed for irrigation, and power production related to it, to permit twice annual flooding. This would avoid the loss of this important benefit of the annual uncontrolled floods.

This approach is not without its cost, however, under the "no-new-irrigation" maximum electricity sales to Mogadishu scheme. IMPRESIT simulations indicate a drop in average annual energy production from 323 to 252 million kilowatt hours (GWh) due to the artificial flooding in the case where only the valley demand for electricity is considered. This overstates the actual loss of energy since the higher demand of Mogadishu would allow a greater portion of the artificial flood waters to be utilized for power production. Still, the loss of power production would be substantial and would reduce the rate of return of the no-irrigation alternative evaluated by COYNE and BELLIER (1981).

c. Future Family Farm Irrigation on the River Banks. As mentioned under "excluded benefits", the area currently irrigated by small privately-owned family farms on the banks of the Juba River could be rapid if input markets and public sector services supporting agriculture are strengthened -- as indeed they will have to be if the larger schemes planned under the Juba River Valley Project are to prove viable. At the same time, any of this potential future development that is preempted by the large irrigation schemes should be charged as a cost to the project. In effect, this cost represents production increases that would occur anyway in the absence of the large schemes. From what we have read, this may not be a very important loss. This should be examined along with flood recession agriculture and riverine grazing areas in a study of existing small farmer agriculture in the Valley.

E. Other Considerations

Several other areas need further study before an economic analysis of the proposed dam can be considered to be complete. At this juncture it is dif-

ficult to say whether they will involve net benefits or costs, only that there will be changes.

1. Environmental Impact

One obvious area needing further study is the environmental impact of the proposed project. Reduced flooding should reduce the area hospitable to mosquitoes and tsetse flys, but the irrigation canals will provide access to comfortable habitats close to human settlements for both. Water borne diseases may increase unless precautions are taken to protect the human population. Game populations in the valley will most certainly be affected, but proper development can help control tsetse while respecting essential reserves for the animals. In addition, the Juba estuary will no doubt experience major changes as contamination from fertilizers, pesticides and herbicides increase, salt water intrusion is reduced, and marine life breeding habitats are affected.

2. Soil Classification

There is some concern that the soils in the river valley may not be as suitable for irrigation as the IMPRESIT study suggests. In a study of topographically suitable areas above the dam site, Dickenson (1980) found less than 20% of the land to be suitable for irrigated agriculture, and that only marginally so. The issue is most important in the areas below the dam. Should the project design, as finally developed, anticipate significant benefits from agricultural production, there will be a need for more detailed soil surveys to demonstrate that such benefits are, indeed, realizable.

3. Supply of Inputs and Supporting Services

Several assumptions in the IMPRESIT analysis presuppose effective supporting agricultural research, extension, input supply and marketing institutions. Some of these may emerge from current efforts to strengthen existing institutions. However, we concur with the IBRD that short-term efforts ought to concentrate on making work what already exists rather than creating new projects which place additional demands on scarce skilled manpower and foreign exchange resources. Once these institutions are functioning properly, and existing irrigated farms can achieve the kind of operating efficiency and yields envisioned by the IMPRESIT study, then more attention can be given to new schemes along the Juba River Valley. It is important not to lose sight of the fact that it is only productive investment that brings about economic development. Inefficient investments bring about greater underdevelopment.

F. Alternative Approaches to the Baardheere Dam and Development of Agriculture in the Juba River Valley

1. The No-New-Irrigation Scheme

Following the IMPRESIT study, COYNE and BELLIER (1981) did a further evaluation of the Juba River Valley Project. It showed the highest internal rate of return -- about 10 percent -- coming from an alternative that included no new irrigated agriculture. As a consequence, the Government of Somalia prepared a Synthesis Document (Ministry of National Planning - December 1980) which put primary emphasis on the hydroelectric power aspects of the dam and took a more evolutionary approach to agricultural development in the valley. This change in

direction is commendable and reflects considerable pragmatism on the part of the Government. With the subsequent increase in oil prices this shift makes all the more sense provided unanswered questions raised in this report do not reveal even greater offset costs. (NOTE: Flood control benefits attributed to the project by COYNE and BELLIER are almost twice those of IMPRESIT; though it was cited, we were unable to review the source of the data. Inclusion at the level used by IMPRESIT would reduce the rate of return to close to zero. This difference should be resolved as it has such a large impact on the rate of return.)

Nonetheless, the problem of agricultural production in Somalia remains. Sooner or later the country will have to turn to the Juba River Valley to feed itself and expand agricultural exports. As has already been mentioned, the first step should be the strengthening of agricultural research, extension and input supply institutions. Sufficient operational, monetary and fiscal reform should accompany this to enable these institutions and the private sector to function effectively on a continuing basis. Beyond that, attention will have to shift to the improvement of existing irrigated agriculture and then to the development of new irrigated agriculture in the Juba River Valley.

2. Feasibility of Proposed Gravity and Pump Irrigation Systems

Rather than push ahead with irrigation development on a wide front it makes good economic sense to study the alternative sites and begin with the most economic. In theory, the two 100% gravity supplied systems -- near Baardheere and Fanoole -- ought, other things being equal, to be the most economic. In practice, such things as distances from source of supply and markets, topography and suitability of soils for alternative crops will exert an influence on costs and benefits as much as will fuel consumption.

Other things, of course, need to be considered and a reasoned determination can be made only after detailed feasibility studies of the areas are made. Because of its location and its relatively low investment and operating cost, a study of the Fanoole 5L Irrigation District (IMPRESIT designation) might be among the first studies undertaken.

3. More Flexible Approach to Developing Irrigation Infrastructure

Somalia needs to experiment with alternative ways of developing its irrigation infrastructure in an effort to reduce establishment costs. This would be particularly appropriate for the family farms where farmers might be excused irrigation taxes by constructing secondary and tertiary canals themselves. Alternatively, food for work programs might be used. There are numerous examples in West Africa where farmers have grouped together to build irrigated perimeters at a fraction of the cost envisioned for the schemes in the Juba River Valley. AFRICARE anticipates costs at less than $3500/ha in the refugee camps in Somalia. The terms of reference for the proposed study of existing private, cooperative and state irrigation schemes should include a search for such initiatives so as to identify ways and means by which they can be replicated.

The feasibility of using contractors to construct intake, main and branch canals and drains with farmers doing the balance of the system should

be explored. Obviously, effective farmer participation in decision making is a key to making such an approach work; and good planning and organization will be necessary to forestall half-completed systems. Given that over 65% of the $9000 per hectare cost of establishing the irrigation districts goes toward constructing secondary and tertiary canals and on-farm reclamation work, the economic gains might very well be worthwhile.

G. Summary and Conclusions on the IMPRESIT Study

The IMPRESIT study of the Juba River Development Project reflects a lot of detailed work that requires making numerous assumptions concerning project design, project benefits and costs. This review has focused on the reasonability of these assumptions as they relate to economic and agricultural benefits and costs.

IMPRESIT envisions developing up to 200,000 hectares of irrigated agriculture in the Juba River Valley using both gravity and pump irrigation supply systems. It proposes a highly mechanized production technology using state and cooperative farms as implementing agents. It has made very optimistic assumptions concerning irrigation efficiency, the efficiency of agricultural machinery, and input prices. Other optimistic assumptions include those relating to cropping intensity, the project implementation rate, available river flow and the supply of skilled labor. The study has not given adequate attention to the loss of river valley grazing or flood recession agriculture. It also assumes an availability of inputs and supporting public sector institutions that is only beginning to evolve in Somalia.

The IMPRESIT study does not consider the alternative of electricity sales to Mogadishu. In effect, it values electricity from the dam at its cost for irrigation rather than its value to the economy at maximum use. As a consequence, it obtains an internal economic rate of return of 5 to 6 percent. Maximizing sales to Mogadishu would yield around a 10% rate of return under prices then prevailing.

When allowance is made for more realistic input-output assumptions and for subsequent changes in the relative price of energy, it is likely that the rate of return to the project as designed by IMPRESIT would be highly negative. The alternative of power sales to Mogadishu would increase somewhat.

This conclusion is, nonetheless, tenuous. More realistic assumptions and altered energy and input prices are only part of the changes needed to accurately assess the viability of the project. Its net environmental impact is not clear. A cropping mix more oriented to high return crops could increase project benefits. Most importantly, an approach to irrigation development that places more emphasis on manual labor and farmer participation may offer hope for a substantial reduction in establishment costs. At the same time, less emphasis on machinery may reduce risk and lower costs of production, though total production may decline as well.

Five areas require further study before these questions can be answered with confidence:

1. The environmental impact of the proposed dam and irrigation systems.

2. The impact of the dam on flood recession and small family irrigated agriculture both above and below the proposed dam.

3. The impact of the project on dry season grazing for livestock and the likely effect of this on livestock production.

4. Evaluation of alternative approaches to irrigated agriculture currently in use in Somalia and the suitability of each for replication in the Juba River Valley.

5. An investigation of labor problems in the modern agricultural sector in order to identify both their origin as well as feasible solutions.

In the meantime, there is ample work to be done in strengthening input supply and agricultural support institutions and in implementing operational, fiscal and monetary reforms without which additional investment in Somali agriculture is unlikely to have much effect.

IV. Conclusions and Recommendations for Further Action

The analysis of costs of producing cereals under rainfed, recession and irrigated agriculture in Somalia show that they do not differ greatly. This arises primarily from the fact that rainfed production occurs mostly in areas where population is relatively high and wage rates are low. Irrigated cereals production using efficient mechanized production technology, on the other hand, occurs in labor scarce areas and, as a result, wage rates are about double those in the rainfed areas. Although higher wage rates are a benefit to the economy, the probability of realizing them given the scarcity of inputs and lack of supporting infrastructure is low. Until these problems are corrected, it would be unwise to rush into new, highly mechanized agricultural production programs.

More useful would be a serious search for an approach to irrigated farming that meets the need to raise farm income while providing employment for increasing numbers of workers being released from pastoral livestock production. Coupled with this should be sustained and effective measures to strengthen government and private sector institutional and policy support to the agricultural sector. In the absence of institutional and policy changes more favorable to the agricultural sector, the country's growing population will become increasingly concentrated in urban areas, aggravating already severe food deficits.

The IMPRESIT proposal for developing agriculture in the Juba River Valley does not seem suitable for the condition prevailing. The approach is highly mechanized in an environment where lack of inputs, spare parts and skilled labor are already seriously constraining agricultural production. Only by making a highly optimistic set of assumptions relating to efficiency of irrigation and mechanization, the cost of operating machinery, and by ignoring the benefits of hydropower to the rest of the country does the study arrive at its 5 percent internal economic rate of return. The study also ignores the impact

of the dam and the proposed irrigation schemes on existing grazing lands and flood recession agriculture. There is no doubt that more realistic cost and use assumptions would result in a highly negative internal rate of return as currently designed.

This does not mean that agricultural development in the Juba River Valley is uneconomic -- only the approach suggested by IMPRESIT. Other more efficient approaches are no doubt currently in use in Somalia, and a study to identify them and the conditions under which they can be effective would provide most useful information.

With respect to the Juba River Valley dam project, the next step is to assess the cost to the economy of less grazing and flood recession agriculture in the valley. If this is not too great, the Government of Somalia should undertake a new economic analysis of the dam assuming maximum supply of power to Mogadishu, using updated prices for machinery, supplies and energy, all of which have changed greatly since 1978. Should this prove promising the stage is set for a full scale environmental impact study prior to making an irrevocable decision on whether to go ahead with the dam.

PART III

JUBA RIVER VALLEY DEVELOPMENT: SOCIAL ISSUES

Susan E. Gunn
Sociologist

I. INTRODUCTION

The purpose of this portion of the study is to identify the social issues which are likely to be of concern in the development of the Juba River Valley as it is currently planned.

The Main Report which will be submitted separately includes, as well, a review and evaluation of the sociological work undertaken to date relevant to the Juba Valley, and an assessment of topics requiring further study.

II. SUMMARY OF ISSUES

These issues summarize the interactions which are likely to occur between the developments proposed for the Juba Valley and the people who live there. It is important to remember that this listing is based only on a literature review, not actual field study, and so does not reveal the complexities or subtleties that are likely to exist on the ground. It may, however, suggest areas for further inquiry and indicate in a very broad way the seriousness of the social impacts in relation to economic and technical factors.

Issues A to D below relate to the effect socio-cultural factors may have upon the construction of the dam and the implementation of irrigation schemes. Conversely, Issues E to O identify the effects the dam and development projects are likely to have upon the society.

A. Size of Labor Force

Roughly 554,000 people reside in the districts through which the river passes, according to 1978 IMPRESIT calculations. The labor force is estimated at 104,790 (including nomads) by these same sources. For heavy labor demands, eg. dam construction, 24,000 males ages 15 to 55 are estimated within the IMPRESIT "Study Area".

IMPRESIT deduces from these statistics that there is a severe shortage of labor in the Valley, and therefore, mechanization is imperative. The experience of other state-controlled enterprises and some private concerns on the Juba bears this out. However, whether this labor shortage is really due to numerical scarcity or to the socio-economic conditions obtaining on the large schemes -- low pay relative to mixed farming, periodic rather than year-round employment, minimal choices as to living situations or even possibly to poor statistics is not known. A much better assessment could be made if we could look at the labor availability on small family farms where, presumably, working conditions are culturally familiar. In fact, before adequate technical planning can be done, the demographic data base for the Juba River catchment area must be improved.

Seen from a wider perspective, it appears short-sighted to create a capital-intensive system in a country whose unemployment rate is burgeoning ans whose major economic base, nomadic pastoralism, shows signs of not being able to absorb effectively even the natural increase of the population in that sector.

B. Background and Work Attitudes of Labor Force

We can classify the population resident in the Juba Valley into five groups based on a number of factors common to each. However, they represent points on a continuum which shift over time rather than significant ethnic or social differences. The groups are relevant to this discussion in that they possess differing work attitudes and skills and vary in their availability as wage labor.

1. Settled Cultivators. This group is the only one which has distinguishable ethnic characteristics, since its members derive from immigrants and former slaves from the agrarian Bantu societies to the south. Its village structure is distinctive, with a chief-type authority pattern. The economy is based entirely on agriculture; no livestock is kept other than poultry. These farmers reportedly form the core of the banana plantation labor force and are excellent workers. They have been resident in this area for at least two centuries and so have strong ties and a sense of ownership regarding the land.

2. Settled Cultivators -- Nomad Background. Also resident in this region for a considerable period, these groups have their economic base in dryland and irrigated farming in the flood plain. They also raise livestock to some extent, primarily cattle and goats, outside the tsetse area. They live in villages and have long-established traditions of mutual aid groups. They provide some labor to plantations in off-seasons.

3. Itinerant Workers -- Nomad Background. These tend to be younger families or individuals who own animals (camels or cattle and small stock), and who may be involved in dry land farming in the areas adjacent to the Valley. During dry seasons or drought periods, they come to work in the fields of relatives in the villages or on the agricultural schemes. They constitute the group most available for wage labor although their experience in working in a highly organized or directed fashion is limited. They are also more exposed to conflicting demands upon their time posed by the exigencies of the agropastoral system to which they still remain connected, and so may appear unreliable or ambivalent in wage labor situations.

4. Nomadic Pastoralists. The largest population group in the Juba Valley are the pastoralists (estimated at 50% of the total population of the riverine districts). Their lifestyle and movements are dictated by the grazing and water requirements of their livestock; they may also raise sorghum during high rainfall periods. Although they tend to move within consistent areas where they have relatives and customary rights to water, this pattern is often broken during periods of local or regional drought. At present, with livestock prices high and grazing relatively plentiful due to good rains, there is little incentive to move outside the livestock sector and seek wage employment. A marginal group exists, however, whose livestock base was so

badly damaged during the 1975 and 1980 droughts that they are more likely to be open to agriculture and other lifestyle options than formerly.

5. Refugees. Located in eight camps in Gedo Region, refugees from the Ogaden conflict and the the 1980 drought are currently being maintained by the Government of Somalia and international agencies. Plans are underway for the settlement of a small portion of the camp residents, and in-camp agricultural projects for some others. Until government policy clears the way for consideration of permanent settlement of the remainder, they cannot be considered as a legitimate potential labor force for the dam or irrigation projects.

C. Heterogeneity of Population

In the Juba Valley basin there is a greater ethnic, linguistic and economic mix than is found in other rural areas of Somalia. Several linguistic distinctions, varying from accents to dialects, are found sequentially from Brava on the Indian Ocean to the upper reaches of the Valley near the international borders. These are (1) Jimbalazi dialect at Brava, (2) Afjido near the terminus of the Juba, (3) Benaadir dialect on the lower Juba, (4) Swahili, May, Somali hybrid dialect near Kismayu, (5) Afmaymay dialect throughout the river basin agricultural areas, (6) Oromo (Galla) in the border regions. The linguistic differences and attendant cultural variations could generate difficulties in communication during dam construction and on the irrigation schemes. Problems of this nature have already been identified in the Bay Region between Afmaymay speaking cultivators and Benaadir speaking extension workers.

Traditional status differences continue to some degree between those who derive recently from a nomadic background and the traditional riverine agricultural peoples. Systems of alliance and mutual obligation have existed among these people for generations on what appear to be a quite equitable basis; nevertheless, as new systems replace the old and job competition increases it is possible that the status differences could be accentuated. Recent examples of this have occurred in some refugee camps. In dam-related work, some groups may show a reluctance to perform what to them are menial tasks for this reason.

The beneficial aspect of the heterogeneity of the population is that more wide ranging skills are available than might otherwise be the case. Also, nomadic and agriculturally-based individuals are more used to being in close contact and working together than elsewhere in the country. This suggests that on-the-job working relationships may not be a problem.

D. Fuel Requirements

Neither the IMPRESIT nor TECHNITAL studies mention the requirements of the population for firewood and housebuilding materials. As already witnessed in refugee and other settlement areas, a radius of up to seven kilometers from the settlement may be denuded by pedestrian foragers, and a much larger

area by those with donkey carts and motorized vehicles, or by charcoal makers. New roads into the Baardheere area and the influx of labor will create both the demand for wood and accessibility to it. Obviously this can be highly deleterious to the environment, but its effect on the workers is significant too -- time spent in scavenging is lost for more productive activities.

E. Displacement of Refugees and Upper Juba Residents

Although the exact number of people living in the flood plain in the districts of Baardheer, Luuq and Garbahaare is not known, we can estimate that at least 5,000 to 10,000 local villagers and cultivators, and perhaps as many as 40,000 refugees will need to be relocted outside the areas to be inundated. Relocation almost always has severe psychological effects on the relocatees and often causes significant social and eocnomic dislocation as well. Since the number is small and time is available compared with other dam schemes in Africa, it is possible to work with these people to devise a humane relocation plan consistent with their lifestyle requirements.

F. Removal of Riverine Grazing

As many as 57,000 people depend on the river routinely to produce dry season grazing for their animals. The dam is likely to affect the grazing in two ways: (1) it will flood the limited, but necessary dry season reserve in the bottom of the gorge, above the dam and (2) it will eliminate flooding below the dam, which at the present time on an annual and periodic basis, inundates side areas of the flood plain. In these areas grasses grow in the residual moisture and provide feed for animals during the dry seasons when the risk of tsetse is less and the grazing elsewhere is exhausted. At this point, we do not know how much land is now used for grazing exclusively, nor do we know what effect the removal of this resource is likely to have on the economy of the region. It is known, however, that the Juba River and its grazing reserves are the last resort for herds throughout two-thirds of Somalia! When the rains fail, as they did in the 1975-76 drought, and again in 1980, the herders bring their surviving animals to the Juba and Shebelli where they remain until the rains are sufficient again. Ongoing research indicates that the majority of the herds based in the Bay Region (one of the few cattle producing areas in Somalia) is dependent on the Juba for annual dry season grazing.

In addition to the grazing reserves, the riverine pastures, augmented by crop residues, are used on a year round basis for the lactating cattle and small stock which nourish the population's residents in the Valley. Although animal products are an important element in the Somali diet -- both out of preference and protein/calorie input -- the major irrigation schemes have, in general, not made adequate provision for it, and in some cases, eg. IMPRESIT settlements, disregard it entirely. (Lactating stock are usually vaccinated against trypanosomiasis.)

G. Removal of Flood Irrigation Agriculture

It is estimated that over 42,000 people are dependent on what is variously called flood recession, inundation or "deshek" agriculture. In this system flood waters and rains fill shallow depressions near the river,

which retain the moisture for several months. As the water recedes, the moist meridians are planted in crops. IMPRESIT proposed to maintain parts of the traditional system through controlled flooding from the reservoir but the manageability of this might be very difficult.

H. Forms of Organization

The settlement models put forward by TECHNITAL and IMPRESIT to be utilized in the irrigation scheme are basically similar to those being attempted at other sites. Highly organized and centralized schemes such as those at Kurtenwaare have been almost uniformly unsuccessful in achieving self-sufficiency or in retaining an active and satisfied labor force. Besides economic factors, cultural factors are known to play a significant role in this because schemes which yield basically the same wages but, like the fishing settlements, provide more independence through small rather than large groups, and involve some real participation in decision making are measurably more successful.

Even with such experience at hand, large scale projects are still being planned and funded (see Five Year Development Plan, 1981-1986). Irrigation schemes based on existing village systems or individual small holders -- which is the traditional approach -- have not as yet been considered.

J. Interception of Trade and Cross-River Movement

During low flow seasons (approximately three months) and at other times via ferry, a vigorous cross river commerce occurs at various points on the upper river. With the reservoir filled, the local trade (for example, in milk) will be altered and the long distance trade and livestock movement will be diverted via either Baardheere or Luuq, a distance of 180 kilometers. We have no data from the region with which to evaluate the effects of these changes.

K. Land and Water Rights

Legislation clearly states that the government owns all land and significant bodies of water, but it is unclear in who may procure rights to rangeland, what the size of agricultural holdings may be (cooperatives and individuals have different allowances), and how consistently the land must be used and in what fashion. Restrictions have been lifted on the marketing of agricultural produce making investment in the agricultural sector potentially more profitable than it has been. Consequently, demand for land and access to water has increased.

Islamic and customary land-and water-use rules are still maintained at the local level where community authority structures are intact: in new irrigation schemes and rapidly developing areas the customary checks and balances are no longer effective in ensuring access by the majority. Increasingly, individual or corporate interests are taking advantage of legal loopholes to consolidate control over scarce resources -- depressions and other well watered sections of the range, irrigable farm land, and water points. The effect of this in the Juba Valley may be to (1) restrict access of livestock to the river

for watering, (2) shift former communal grazing land, especially the marine soil areas, into private agricultural holdings, (3) eliminate small holders from areas claimed for major new irrigation schemes, (4) replace small farmers holding customary rights by those (often outsiders) with government recognized registration. Such changes are likely to precede dam and irrigation scheme development and so must be addressed in the early planning stages before a full scale "land/water grab" gets underway. Measures to be taken include: land registration of current holders, and incorporation rather than displacement of small holders.

L. Increased Conflicts

Evidence from existing irrigation schemes indicates that increasing population pressure due to creation of a settlement or to the agricultural use of lands previously used for grazing, can instigate conflict between groups. Nomadic herders previously accustomed to riverine grazing on the Juba retaliate against agricultural incursions by allowing their herds to feed on crops. Although perhaps not significant in themselves such incidents are symptomatic of a larger tension producing situation -- the scarcity of reserve grazing. Careful management via local authority systems and long standing intergroup ties could reduce this problem, but at this point the planned developments make no provision for this.

M. Increased Urbanization

Electricity and new roads alone are likely to bring about significant changes in the lives of isolated, rural villagers. They are also likely to initiate a spiral of changes including increased demand for consumer products and government services (eg. health and education). Experience elsewhere in Somalia shows that the new villages and enlarged existing villages constitute a magnet to the surrounding areas, drawing in young men and marginal families who have been precipitated out of the agropastoral sector by drought, land alienation or other problems. This trend is desirable from the point of view of labor, but requires careful planning simply in order to provide for the basic needs of the newcomers. Currently, 168,600 people within the Juba Valley study area are considered urbanized.

The creation of new urbanized centers is likely to have a profound effect on the surrounding rural sector as well. The existing linkages within the agropastoral system which connect range and farms and market are likely to become the channel for both new consumer goods (and the values which accompany them) as well as for new investment opportunities. If the people currently operating within the Juba River agropastoral system can retain control of it, the potential growth will benefit them. It is likely to be detrimental to them if it becomes dominated by external interests -- whether they are international, corporate, or private makes little difference.

N. Changed Nutritional Levels

There is some evidence from Somalia indicating that nomads' nutritional levels are quite good, except during dry periods when milk is limited; similarly, small agricultural families are considered to be well nourished given

the wide variety of vegetable and grain products to which they have access. Interestingly, the best nourished are considered to be those who reside on the lower Juba who, through family ties and agreements with other groups have access to both animal and vegetable products. The least well nourished are urban dwellers whose protein intake is primarily from cereals, who are more subject to market forces in obtaining their total caloric needs, and whose consumption patterns are changing to favor more expensive, but less nutrient-dense foods.

Therefore, as urbanization increases in the Valley and if, as planned, single sector or cash crop schemes continue to be the dominant pattern, one can expect that the population will increasingly be nourished via the market rather than as previously via their own local animal and plant produce. Obtaining adequate protein on an agricultural settlement becomes especially difficult as witnessed by experience at a number of settlements, and specific dietary deficiencies may arise such as the recent outbreak of scurvy (Vitamin C deficiency) at some refugee camps. The synergistic effect of low iron intake (due to lack of meats and certain vegetables) and anemias created by schistosomiasis, malaria and parasites may result in a dangerously weakened and susceptible labor force.

O. Increase in Disease

Slowing the flow of water and expanding the area it covers creates a favorable environment for the spread of two diseases already present in the area -- falciparum malaria and schistosomiasis haematobium.

Although data are poor from this area, W.H.O. staff estimate a 100% increase in malaria incidence in the Juba basin if the plan proceeds as proposed and vigorous control measures are not adopted. Deaths, especially of infants will increase. It has been estimated that the requisite studies of vectors and habitats, spraying, treatment for the affected population, and ongoing surveillance would require an investment of U.S. $1 million for the Juba Valley. IMPRESIT and others acknowledge the need for control, but make no provision for it.

Similarly, schistosomiasis, now estimated to infect roughly 40 to 50 percent of the riverine population and extending up to 200 kilometers away from the river itself will become an even more serious threat when irrigation canals are extended and the reservoir fills. Control of this desease is likely to be much easier if measures are carried out before the dam is built and if canals and other infrastructure are planned so as to minimize this hazard.

Diarrheal diseases are an equally serious problem and reportedly affect an even greater percentage of the population. Since most people are accustomed to obtaining their drinking water from the river, increases in population concentration will automatically increase prevalence of these diseases as well unless new water sources are developed.

New diseases for which there are no prophylaxes or treatments are showing up in connection with irrigation schemes in East Africa. Rift Valley

Fever, for example, is found in all surrounding countries, but not yet in Somalia...presumably because there is no dam here yet!

III. CONCLUSIONS

A field-based social feasibility study has not been done yet for either the Juba Valley dam or the downstream irrigation projects. Moreover, essential background information on which to base such a study (for example, data on demographic composition and economic production systems in the region) are also lacking.

There is a temptation to leave aside such study until the dam is decided, if not well on its way, and then to frame the social analysis strictly in terms of the subsequent development schemes. This is inadvisable for two reasons: (1) labor is needed for the dam itself; therefore, it is essential to assess how much labor is already present at what skill levels, and the factors determining its availability (eg. incentives, working conditions), and (2) the dam itself will have a powerful impact on the surrounding society, apart from any other planned development. The most profound effect will be that of several hundred million dollars of services, commodities and salaries moving into what is now a relatively isolated rural area. Significant changes can be expected in the local economy and authority structures. The influx and concentration of population for dam construction alone may well trigger a long term urbanization process in several centers in the Valley, demanding in turn more housing, social services, government organization, food and other consumer goods than would otherwise be the case if natural increase alone were operating.

These changes cannot be labeled a priori as beneficial or deleterious -- the extent to which they are effectively guided will determine that. However, serious account must be taken at the outset of the potentially negative effect this influx of population and money will have on the host population currently resident in the Juba Valley. Both settled and nomad groups currently dependent on the Valley as it now exists (floods and all) can be expected to suffer:

1. Psychological shock;

2. Alienation of their land and/or means of livelihood (grazing) to more sophisticated interests;

3. Disruption or monetization of long standing social ties based on mutual obligation; and

4. Increase in the cost of living.

Over half a million people are potentially subject to these effects.

Turning, then, to the Juba Valley Development Program as a whole, and seeing the dam as only one element in a larger development context, it becomes even more obvious that social factors may be a primary determinant in the success of the overall program. This is so for the following reasons: